Set 9.0: Molar Mass

Skill 9.01: Calculate the mass in grams of sample of atoms
Skill 9.02: Define "mole"
Skill 9.03: Convert between moles and mass in grams and visa versa

Skill 9.01: Calculate the mass in grams of sample of atoms

Skill 9.01 Concepts

Recall that the mass of an individual atom is the sum of its protons and neutrons. For example, the mass of the carbon-12 isotope shown below is 12 amu. (amu = atomic mass units)

$^{12}_{6}C$

An atomic mass unit, also known as a Dalton, is equal to 1.66054×10^{-24} g,

$$1 \text{ amu} = 1.66054 \times 10^{-24} \text{ g} \qquad (1)$$

The equality shown above enables one to convert amu to a useful unit, grams.

Skill 9.01 Example 1

(a) What is the mass in amu of 1 hydrogen-1 atom?	What is the mass in grams of 1 hydrogen atom?
(b) What is the mass in amu of 1 carbon-12 atom?	What is the mass in grams of 12 carbon atoms?
(c) What is the mass in grams of 6.022×10^{23} hydrogen-1 atoms?	
(d) What is the mass in grams of 6.022×10^{23} carbon-12 atoms?	

Skill 9.02: Define "mole"

Skill 9.02 Concepts

In the above example, we saw that the mass of an individual atom is VERY small. Rather than trying to weigh an individual atom, chemists weigh large quantities of atoms. The quantity used in chemistry is called a mole. A mole represents a quantity much like a dozen does.

$$1 \text{ dozen} = 12 \text{ things} \qquad (2)$$

$$1 \text{ mole} = 6.022 \times 10^{23} \text{ things} \qquad (3)$$

The number 6.022×10^{23} is also referred to as Avogadro's number.

Skill 9.02 Example 1

(a) How many dozens of atoms are 36 hydrogen atoms?
(b) How many dozens of atoms are 1.22×10^{21} carbon atoms?
(c) How many moles of atoms are 3.011×10^{23} hydrogen atoms?
(d) How many atoms of carbon are in 2.0 moles?

Skill 9.03: Convert between moles and mass in grams and visa versa

Skill 9.03 Concepts

Notice that a mole of atoms is a VERY large amount, therefore one would expect many different isotopes in this mix. The average mass of a mole of atoms is given by the mass number of that element expressed in grams.

For example one mole of hydrogen atoms contains 6.022×10^{23} atoms and has a mass of 1.011 g

Molar mass is defined as the mass of 1 mole of atoms and is given as the mass number on the periodic table. For example the molar mass of helium is 4 g/mol, and that of carbon is 12 g/mol.

$$1 \text{ mole} = 6.022 \times 10^{23} \text{ atoms} = \text{mass number (g)} \qquad (4)$$

The relationship above is VERY useful. It serves as a way to convert between moles, atoms, and grams for any element. This is illustrated in following problems.

Skill 9.03 Example 1

(a) What is the mass of 6.022×10^{23} atoms of the following:			
(i) hydrogen	(ii) oxygen	(iii) carbon	(iv) phosphorous
(b) What is the mass of 1 mole of the following:			
(i) nitrogen	(ii) aluminum	(iii) argon	(iv) lead
How many moles is in each of the following:			
(i) 23 g of sodium	(ii) 2 g of helium	(iii) 2 g of hydrogen	(iv) 1 g of mercury
How many atoms is in each of the following			
(i) 11.5 g of sodium	(ii) 20. g of argon	(iii) 32 g of oxygen	(iv) 2.0 g of potassium